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Final Technical Report

Project Title: Case Studies of Explosive Oceanic Cyclogenesis

Contract Number: ONR-N00014-87-K-0209

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1. Project Summary

Research during the first year of this contract (see progress report under cover letter of 8 February 1989 to Dr. Robert F. Abbey, Jr.) consisted of studies of historical oceanic storms which traversed the ERICA region. Mesoscale, synoptic scale and planetary scale features that preceded and accompanied the cyclogenesis were examined and documented in an effort to isolate meteorological signatures common to all the storms.

The second year of research (see progress report under cover letter of 11 December 1989 to Dr. Robert F. Abbey, Jr.) featured continued research on four pre-ERICA explosive oceanic storms. This research demonstrated that oceanic cyclogenesis responded to a spectrum of atmospheric forcing ranging from purely baroclinic to more nearly equivalent barotropic with convection playing an important modifying role. East Coast oceanic storms associated with coastal frontogenesis were also shown to have an antecedent signature in the planetary scale 1000-500 mb thickness field whereby negative thickness anomalies were present across much of Europe, eastern Asia, and the western Pacific prior to the actual cyclogenesis.

The third year of research (see progress report under cover letter of 21 November 1990 to Dr. Robert F. Abbey, Jr.) featured a detailed analysis (conducted jointly with Dr. Frederick Sanders) of the poorly simulated explosive oceanic cyclone of 4 October 1987 by the existing operational NMC prediction models. Preliminary results revealed the crucial importance of representing the wind, temperature and moisture fields properly in the planetary boundary layer to the successful prediction of the onset and location of oceanic cyclogenesis. Research also began on the identification of distinct types of oceanic cyclogenesis based on satellite-derived cloud classifications. A total of four distinct types of cyclogenesis were identified from a sample of 51 cyclones in the pre-ERICA and ERICA periods.

The fourth and final year of research (see progress report under cover letter of 5 December 1991 to Robert F. Abbey, Jr.) resulted in the completion of the October 1987 explosive oceanic cyclone study and the publication of the results in the refereed literature.

The preliminary results described above were affirmed and the importance of sensible cooling associated with melting snow in creating an isothermal layer near °C in the boundary layer which resulted in changing rain to snow was demonstrated. The satellite-derived cloud classification study was completed with the results summarized in the above technical report. Briefly, the principal cloud signatures seen in the visible and infrared satellite imagery could be identified with distinct dynamic, thermodynamic and kinematic signatures. A paper describing our principal scientific results with application to ERICA cyclones will be prepared and submitted for publication in 1992.

2. Index of Technical Reports:

(a) FY-88: Letter to Dr. Robert F. Abbey, Jr. dated 8 February 1988.
(b) FY-89: Letter to Dr. Robert F. Abbey, Jr. dated 11 December 1989.
(c) FY-90: Letter to Dr. Robert F. Abbey, Jr. dated 21 November 1990.
(d) FY-91: Letter to Dr. Robert F. Abbey, Jr. dated 5 December 1991.

3. Index of All Publications:

(a) Bell, G. and L. F. Bosart, 1989: A 15 year climatology of Northern Hemisphere 500 mb closed cyclone and anticyclone centers. *Mon. Wea. Rev.*, **117**, 2142-2163.

(b) Rogers, E., and L. F. Bosart, 1991: A diagnostic study of two intense oceanic cyclones. *Mon. Wea. Rev.*, **119**, 965-996.

(c) Bosart, L.F. and F. Sanders, 1991: An Early-season coastal storm: Conceptual success and model failure. *Mon. Wea. Rev.*, **119**, (In Press).

(d) Sanders, F., L. F. Bosart, and C.-C. Lai, 1991: Initiation and evolution of an intense upper-level front. *Mon. Wea. Rev.*, **119**, 1337-1367.

(e) Evans, M. S., L. F. Bosart, and D. Keyser, 1992: A Satellite-Deprived Classification Scheme for Rapid Maritime Cyclogenesis, *Preprints*, Symposium on Weather Forecasting, American Meteorological Society, Atlanta, Georgia, January 5 - 10, 1992.

4. Thesis Titles and Students

Completed:

(a) Masters:
Mike Evans: "Satellite Signatures Associated with Explosive Oceanic Cyclogenesis" (shared with Professor Daniel Keyser).

(b) Ph.D.:
Gerald Bell: "Synoptic-Dynamic Aspects of Cutoff Cyclones".

Eric Rogers: "A Case Study of Intense Oceanic Cyclones".

In Progress:

(a) Ph.D.:
Gary Lackmann: "Oceanic Cyclogenesis" (shared with Professor Daniel Keyser).